

The documentation and process conversion measures necessary to comply with this revision shall be completed by 11 July 2008.

INCH-POUND

MIL-PRF-19500/683C  
11 April 2008  
SUPERSEDING  
MIL-PRF-19500/683B  
23 December 2004

## PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, FIELD EFFECT, N-CHANNEL,  
RADIATION HARDENED (TOTAL DOSE AND SINGLE EVENT EFFECTS)  
TYPE 2N7467U2, JANTXVR, F, G, AND H AND JANSR, F, G, AND H

This specification is approved for use by all Departments  
and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of  
this specification sheet and MIL-PRF-19500.

### 1. SCOPE

\* 1.1 Scope. This specification covers the performance requirements for an N-channel, enhancement-mode power MOSFET transistor with radiation hardened total dose and single event (SEE) effects ratings, with avalanche energy maximum rating ( $E_{AS}$ ) and maximum avalanche current ( $I_{AS}$ ). Two levels of product assurance are provided for each device type as specified in MIL-PRF-19500. See 6.5 for JANHC and JANKC die versions.

1.2 Physical dimensions. See figure 1, surface mount, TO-276AC, (SMD-2).

\* 1.3 Maximum ratings. Unless otherwise specified,  $T_A = +25^\circ\text{C}$ .

| Type     | $P_T$ (1)<br>$T_C = +25^\circ\text{C}$ | $P_T$<br>$T_A = +25^\circ\text{C}$<br>(free air) | $R_{\theta JC}$<br>(2)               | $V_{DS}$    | $V_{DG}$    | $V_{GS}$    | $I_{D1}$<br>$T_C = +25^\circ\text{C}$<br>(3) (4) | $I_{D2}$<br>$T_C = +100^\circ\text{C}$<br>(3) (4) | $I_S$       | $I_{DM}$<br>(5) | $T_J$<br>and<br>$T_{STG}$          |
|----------|--|--|--------------------------------------|-------------|-------------|-------------|--|---|-------------|-----------------|------------------------------------|
|          | <u>W</u>                               | <u>W</u>   | <u><math>^\circ\text{C/W}</math></u> | <u>V dc</u> | <u>V dc</u> | <u>V dc</u> | <u>A dc</u>                                      | <u>A dc</u>                                       | <u>A dc</u> | <u>A(pk)</u>    | <u><math>^\circ\text{C}</math></u> |
| 2N7467U2 | 250                                    | 2.5  | 0.50                                 | 30          | 30          | $\pm 20$    | 75   | 75  | 75          | 300             | -55 to<br>+150                     |

(1) Derate linearly 2.0 W/ $^\circ\text{C}$  for  $T_C > +25^\circ\text{C}$ .

(2) See figure 2, thermal impedance curves.

(3) The following formula derives the maximum theoretical  $I_D$  limit.  $I_D$  is limited by package and device construction to 75 Amps:

$$I_D = \sqrt{\frac{T_{JM} - T_C}{(R_{\theta JC}) \times (R_{DS(on)} \text{ at } T_{JM})}}$$

(4) See figure 3, maximum drain current graph.

(5)  $I_{DM} = 4 \times I_{D1}$  as calculated in note (3).

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to [Semiconductor@dsccl.dla.mil](mailto:Semiconductor@dsccl.dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil/>.

1.4 Primary electrical characteristics at  $T_C = +25^\circ\text{C}$ .

| Type     | Min<br>$V_{(BR)DSS}$<br>$V_{GS} = 0$<br>$I_D = 1.0$<br>mA dc | $V_{GS(TH)}$<br>$V_{DS} \geq V_{GS}$<br>$I_D = 1.0$<br>mA dc |       | Max $I_{DSS1}$<br>$V_{GS} = 0$<br>$V_{DS} = 80$<br>percent of<br>rated $V_{DS}$ | Max $r_{DS(ON)} (1)$<br>$V_{GS} = 12 \text{ V dc}$ |  | $E_{AS}$<br>at $I_{D1}$ | $I_{AS}$ |
|----------|--|--|-------|---|--|--|-------------------------|----------|
|          |  |  |       |   | $T_J = 25^\circ\text{C}$<br>at $I_{D2}$            | $T_J = 150^\circ\text{C}$<br>at $I_{D2}$ |                         |          |
| 2N7467U2 | <u>V dc</u>  | <u>V dc</u>  |       | <u><math>\mu\text{A dc}</math></u>  | <u>ohm</u>   | <u>ohm</u>                               | <u>mJ</u>               | <u>A</u> |
|          |  | Min  | Max   |   |  |  |                         |          |
|          |  | 2.0  | 4.0   |   |  |  |                         |          |
|          |  | 10   | .0035 |   |  |  |                         |          |

(1) Pulsed (see 4.5.1).

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

## DEPARTMENT OF DEFENSE SPECIFICATIONS

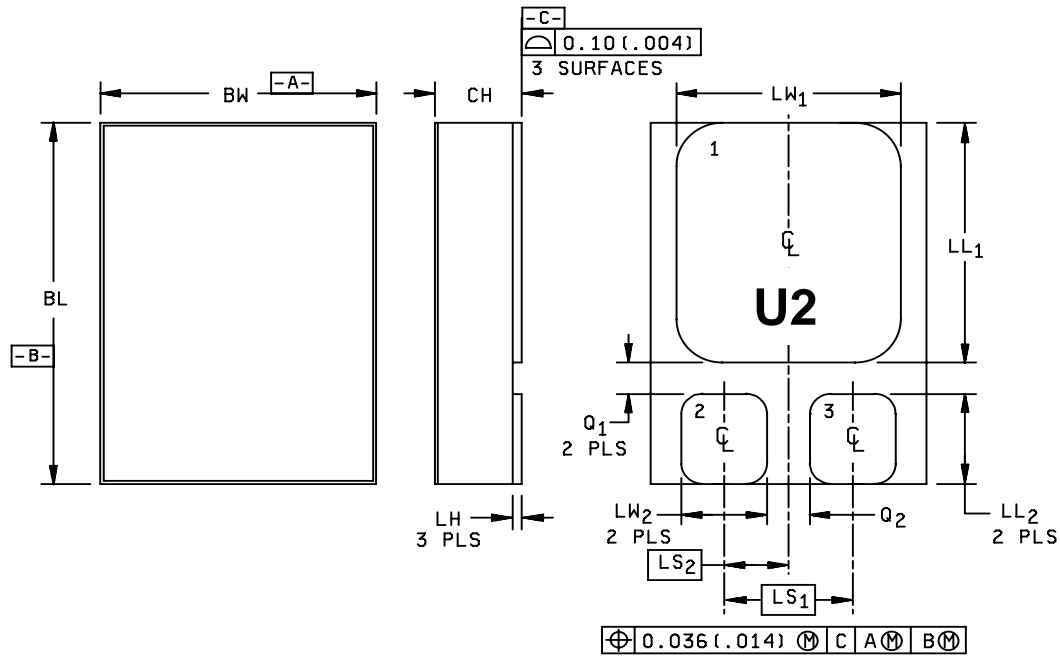
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

## DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.



| LTR | Dimensions |      |             |       |
|-----|------------|------|-------------|-------|
|     | Inches     |      | Millimeters |       |
|     | Min        | Max  | Min         | Max   |
| BL  | .685       | .695 | 17.40       | 17.65 |
| BW  | .520       | .530 | 13.21       | 13.46 |
| CH  |            | .142 |             | 3.60  |
| LL1 | .470       | .480 | 11.94       | 12.19 |
| LL2 | .152       | .162 | 3.86        | 4.11  |
| LH  | .010       | .020 | .254        | .508  |
| LS1 | .240 BSC   |      | 6.10 BSC    |       |
| LS2 | .120 BSC   |      | 3.05 BSC    |       |
| LW1 | .435       | .445 | 11.05       | 11.30 |
| LW2 | .135       | .145 | 3.43        | 3.68  |
| Q1  | .035       |      | .89         |       |
| Q2  | .050       |      | 1.27        |       |

## NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Dimensions and tolerancing shall be in accordance with ASME Y14.5M.
4. Terminal 1 – Drain, Terminal 2 – Gate, Terminal 3 – Source

FIGURE 1. Physical dimensions for surface mount - 2N7467U2 (TO-276AC).

### 3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500 and as follows:

$I_{AS}$ .....Rated avalanche current, nonrepetitive  
nC .....nano Coulomb.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (U2, TO-276AC) herein. Methods used for the electrical isolation of the terminals shall employ materials that contain a minimum of 90 percent  $Al_2O_3$  (ceramic).

3.4.1 Lead material and finish. Terminal material shall be copper tungsten. Terminal finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of terminal finish is desired, it shall be specified in the acquisition document (see 6.5).

3.4.2 Internal construction. Multiple chip construction is not permitted to meet the requirements of this specification.

3.5 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.6 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection.

3.6.1 Handling. MOS devices must be handled with certain precautions to avoid damage due to the accumulation of static charge. However, the following handling practices are recommended (see 3.6).

- a. Devices should be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber, or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.
- h. Gate must be terminated to source,  $R \leq 100 \text{ k}\Omega$ , whenever bias voltage is to be applied drain to source.

3.7 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.8 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

#### 4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III tests, the tests specified in table III herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.2.1.1 SEE. Design capability shall be tested on the initial qualification and thereafter whenever a major die design or process change is introduced. See the design safe operation area graph shown herein. End-point measurements shall be in accordance with table III.

4.3 Screening (JANS, JANTXV levels only). Screening shall be in accordance with table E-IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

| Screen (see table E-IV of MIL-PRF-19500)<br>(1) (2) | Measurement   |  |
|---|---|--|
|   | JANS level  | JANTXV level   |
| (3)   | Gate stress test (see 4.3.1)  | Gate stress test (see 4.3.1)   |
| (3)   | Method 3470 of MIL-STD-750, E <sub>AS</sub> (see 4.3.2)   | Method 3470 of MIL-STD-750, E <sub>AS</sub> (see 4.3.2)  |
| (3) 3c  | Method 3161 of MIL-STD-750, thermal impedance, (see 4.3.3)  | Method 3161 of MIL-STD-750, thermal impedance, (see 4.3.3)   |
| 9   | Subgroup 2 of table I herein;<br>I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub>  | Not applicable   |
| 10  | Method 1042 of MIL-STD-750, test condition B  | Method 1042 of MIL-STD-750, test condition B   |
| 11  | Subgroup 2 of table I herein;<br>I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub> , r <sub>DS(on)1</sub> , V <sub>GS(TH)1</sub><br><br>$\Delta I_{GSSF1} = \pm 20 \text{ nA dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br>$\Delta I_{GSSR1} = \pm 20 \text{ nA dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br>$\Delta I_{DSS1} = \pm 5 \text{ } \mu\text{A dc or } \pm 100 \text{ percent of initial value, whichever is greater}$                                  | Subgroup 2 of table I herein;<br>I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub> , r <sub>DS(on)1</sub> , V <sub>GS(TH)1</sub>   |
| 12  | Method 1042 of MIL-STD-750, test condition A  | Method 1042 of MIL-STD-750, test condition A   |
| 13  | Subgroups 2 and 3 of table I herein<br><br>$\Delta I_{GSSF1} = \pm 20 \text{ nA dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br>$\Delta I_{GSSR1} = \pm 20 \text{ nA dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br>$\Delta I_{DSS1} = \pm 5 \text{ } \mu\text{A dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br><br>$\Delta r_{DS(on)1} = \pm 20 \text{ percent of initial value}$<br>$\Delta V_{GS(th)1} = \pm 20 \text{ percent of initial value}$ | Subgroup 2 of table I herein<br><br>$\Delta I_{GSSF1} = \pm 20 \text{ nA dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br>$\Delta I_{GSSR1} = \pm 20 \text{ nA dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br>$\Delta I_{DSS1} = \pm 5 \text{ } \mu\text{A dc or } \pm 100 \text{ percent of initial value, whichever is greater}$<br><br>$\Delta r_{DS(on)1} = \pm 20 \text{ percent of initial value}$<br>$\Delta V_{GS(th)1} = \pm 20 \text{ percent of initial value}$ |

- (1) At the end of the test program, I<sub>GSSF1</sub>, I<sub>GSSR1</sub>, and I<sub>DSS1</sub> are measured.
- (2) An out-of-family program to characterize I<sub>GSSF1</sub>, I<sub>GSSR1</sub>, I<sub>DSS1</sub>, and V<sub>GS(th)1</sub> shall be invoked.
- (3) Shall be performed anytime before screen 9.

4.3.1 Gate stress test. Apply  $V_{GS} = 24$  V minimum for  $t = 250$   $\mu$ s minimum.

4.3.2 Single pulse avalanche energy ( $E_{AS}$ ).

- a. Peak current ( $I_{AS}$ ) .....  $I_{AS(max)}$ .
  - \* b. Peak gate voltage ( $V_{GS}$ ) ..... 12 V minimum up to rated  $V_{GS}$  maximum.
  - c. Gate to source resistor ( $R_{GS}$ ) .....  $25\Omega \leq R_{GS} \leq 200\Omega$ .
  - d. Initial case temperature ( $T_C$ ) .....  $+25^\circ\text{C}$   $+10^\circ\text{C}$ ,  $-5^\circ\text{C}$ .
  - e. Inductance (L) .....  $\left[ \frac{2E_{AS}}{(I_{DI})^2} \right] \left[ \frac{V_{BR} - V_{DD}}{V_{BR}} \right]$  mH minimum.
  - f. Number of pulses to be applied ..... 1 pulse minimum.
  - \* g. Supply voltage ( $V_{DD}$ ) ..... 25 V minimum up to rated  $V_{GS}$  maximum.
- \* 4.3.3 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3161 of MIL-STD-750 using the guidelines in that method for determining  $I_M$ ,  $I_H$ ,  $t_H$ ,  $t_{SW}$ , (and  $V_H$  where appropriate). Measurement delay time ( $t_{MD}$ ) = 70  $\mu$ s max. See table III, group E, subgroup 4 herein.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table E-V of MIL-PRF-19500. End-point electrical measurements shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIA (JANS) and table E-VIB (JANTXV) of MIL-PRF-19500, and as specified herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2.1 Group B inspection, appendix E, table E-VIA (JANS) of MIL-PRF-19500.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u>  |
|-----------------|---------------|---|
| B3              | 1051          | Test condition G, 100 cycles.   |
| B3              | 2075          | See 3.4.2.  |
| B3              | 2077          | Scanning electron microscope (SEM) qualification may be performed anytime prior to lot formation.   |
| B4              | 1042          | Test condition D, 2,000 cycles. Neither heat sink nor forced-air cooling on the device shall be permitted during the on cycle. The heating cycle shall be 60 seconds minimum. |
| B5              | 1042          | Test condition B, $V_{GS} = \text{rated}$ ; $T_A = +175^\circ\text{C}$ , $t = 24$ hours.  |
| B5              | 1042          | Test condition A, $V_{DS} = \text{rated}$ ; $T_A = +175^\circ\text{C}$ ; $t = 120$ hours.   |
| * B5            | 2037          | Bond strength; test condition D.  |

\* 4.4.2.2 Group B inspection, table E-VIB (JANTXV) of MIL-PRF-19500.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u>  |
|-----------------|---------------|---|
| B2              | 1051          | Test condition G, 25 cycles. (45 total, including 20 cycles performed in screening).  |
| B3              | 1042          | Test condition D, 2,000 cycles. Neither heat sink nor forced-air cooling on the device shall be permitted during the on cycle. The heating cycle shall be 60 seconds minimum. |
| B4              | 2075          | See 3.4.2.  |

\* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with table I, subgroup 2 herein.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u>  |
|-----------------|---------------|---|
| C2              | 1056          | Test condition B.   |
| C2              | 1021          | Omit initial conditioning.  |
| * C5            | 3161          | See 4.5.2.  |
| C6              | 1042          | Test condition D, 6,000 cycles. Neither heat sink nor forced-air cooling on the device shall be permitted during the on cycle. The heating cycle shall be 60 seconds minimum. |

4.4.4 Group D Inspection. Group D inspection shall be conducted in accordance with appendix E, table E-VIII of MIL-PRF-19500 and table II herein.

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

\* 4.5.2 Thermal resistance. The thermal resistance measurements shall be performed in accordance with method 3161 of MIL-STD-750 using the guidelines in that method for determining  $I_M$ ,  $I_H$ ,  $t_H$ ,  $t_{SW}$  (and  $V_H$  where appropriate). Measurement delay time ( $t_{MD}$ ) = 70  $\mu$ s max. See MIL-PRF-19500, table E-IX, group E, Subgroup 4.



## MIL-PRF-19500/683C

\* TABLE I. Group A inspection.

| Inspection 1/<br><u>Subgroup 1</u>         | MIL-STD-750 |   | Symbol          | Limits |           | Unit                 |
|--|-------------|---|-----------------|--------|-----------|----------------------|
|  | Method      | Conditions  |                 | Min    | Max       |                      |
| Visual and mechanical inspection           | 2071        |   |                 |        |           |                      |
| <u>Subgroup 2</u>                          |             |   |                 |        |           |                      |
| * Thermal impedance 2/                     | 3161        | See 4.3.3   | $Z_{\theta JC}$ |        |           | $^{\circ}\text{C/W}$ |
| Breakdown voltage, drain to source         | 3407        | $V_{GS} = 0 \text{ V dc}$ , $I_D = 1 \text{ mA dc}$ , bias condition C              | $V_{(BR)DSS}$   | 30     |           | V dc                 |
| Gate to source voltage (threshold)         | 3403        | $V_{DS} \geq V_{GS}$ , $I_D = 1 \text{ mA dc}$                                      | $V_{GS(TH)1}$   | 2.0    | 4.0       | V dc                 |
| Gate current                               | 3411        | $V_{GS} = +20 \text{ V dc}$ bias condition C, $V_{DS} = 0$                          | $I_{GSSF1}$     |        | +100      | nA dc                |
| Gate current                               | 3411        | $V_{GS} = -20 \text{ V dc}$ , bias condition C, $V_{DS} = 0$                        | $I_{GSSR1}$     |        | -100      | nA dc                |
| Drain current                              | 3413        | $V_{GS} = 0 \text{ V dc}$ , bias condition C, $V_{DS} = 24 \text{ V dc}$            | $I_{DSS1}$      |        | 10        | $\mu\text{A dc}$     |
| Static drain to source on-state resistance | 3421        | $V_{GS} = 12 \text{ V dc}$ , condition A, pulsed (see 4.5.1), $I_D = I_{D2}$        | $r_{DS(on)1}$   |        | .0035     | $\Omega$             |
| Forward voltage                            | 4011        | Pulsed (see 4.5.1), $I_D = I_{D1}$ , $V_{GS} = 0 \text{ V dc}$                      | $V_{SD}$        |        | 1.3       | V                    |
| <u>Subgroup 3</u>                          |             |   |                 |        |           |                      |
| High-temperature operation:                |             | $T_C = T_J = +125^{\circ}\text{C}$  |                 |        |           |                      |
| Gate current                               | 3411        | $V_{GS} = +20 \text{ V dc}$ and $-20 \text{ V dc}$ , bias condition C, $V_{DS} = 0$ | $I_{GSS2}$      |        | $\pm 200$ | nA dc                |
| Drain current                              | 3413        | $V_{GS} = 0 \text{ V dc}$ , bias condition C, $V_{DS} = 24 \text{ V dc}$            | $I_{DSS2}$      |        | 25        | $\mu\text{A dc}$     |
| Static drain to source on-state resistance | 3421        | $V_{GS} = 12 \text{ V dc}$ , pulsed (see 4.5.1), $I_D = I_{D2}$                     | $r_{DS(on)3}$   |        | .0055     | $\Omega$             |
| Gate to source voltage (thresholds)        | 3403        | $V_{DS} \geq V_{GS}$ , $I_D = 1 \text{ mA dc}$                                      | $V_{GS(TH)2}$   | 1.0    |           | V dc                 |
| Low-temperature operation:                 |             | $T_C = T_J = -55^{\circ}\text{C}$   |                 |        |           |                      |
| Gate to source voltage (threshold)         | 3403        | $V_{DS} \geq V_{GS}$ , $I_D = 1 \text{ mA dc}$                                      | $V_{GS(TH)3}$   |        | 5.0       | V dc                 |

See footnotes at end of table.

\* TABLE I. Group A inspection - Continued.

| Inspection <u>1/</u>                    | MIL-STD-750 |  | Symbol       | Limits |     | Unit |
|---|-------------|--|--------------|--------|-----|------|
|   | Method      | Conditions   |              | Min    | Max |      |
| <u>Subgroup 4</u>                       |             |  |              |        |     |      |
| Forward transconductance                | 3475        | $I_D = 45 \text{ A}$ , $V_{DD} = 15 \text{ V}$ (see 4.5.1)   | gFS          | 45     |     |      |
| Switching time test                     | 3472        | $I_D = 45 \text{ A}$ , $V_{GS} = 12 \text{ V dc}$ ,<br>$R_G = 2.35\Omega$ , $V_{DD} = 15 \text{ V dc}$ |              |        |     |      |
| Turn-on delay time                      |             |  | $t_{d(on)}$  |        | 35  | ns   |
| Rise time                               |             |  | $t_r$        |        | 125 | ns   |
| Turn-off delay time                     |             |  | $t_{d(off)}$ |        | 80  | ns   |
| Fall time                               |             |  | $t_f$        |        | 50  | ns   |
| <u>Subgroup 5</u>                       |             |  |              |        |     |      |
| Safe operating area test (high voltage) | 3474        | See figure 4; $t_p = 10 \text{ ms}$<br>$V_{DS} = 24 \text{ V}$   |              |        |     |      |
| Electrical measurements                 |             | See table I, subgroup 2 herein.  |              |        |     |      |
| <u>Subgroup 6</u>                       |             |  |              |        |     |      |
| Not applicable                          |             |  |              |        |     |      |
| <u>Subgroup 7</u>                       |             |  |              |        |     |      |
| Gate charge                             | 3471        | Condition B, $I_D = 45 \text{ A}$  |              |        |     |      |
| On-state gate charge                    |             |  | $Q_{G(on)}$  |        | 200 | nC   |
| Gate to source charge                   |             |  | $Q_{GS}$     |        | 55  | nC   |
| Gate to drain charge                    |             |  | $Q_{GD}$     |        | 40  | nC   |
| Reverse recovery time                   | 3473        | $dI/dt \leq 100 \text{ A}/\mu\text{s}$ ,<br>$V_{DD} \leq 25 \text{ V}$ , $I_D = 45 \text{ A}$          | $t_{rr}$     |        | 165 | ns   |

1/ For sampling plan, see MIL-PRF-19500.

2/ This test is required for the following end-point measurements only (not intended for 4.3, screen 9, 11, or 13):  
Group B, subgroups 3 and 4 (JANS) or group B, subgroups 2 and 3 (JANTXV).  
Group C, subgroups 2 and 6, and Group E, subgroups 1.

## MIL-PRF-19500/683C

\* TABLE II. Group D inspection.

| Inspection<br>1/ 2/ 3/  | MIL-STD-750 |   | Symbol               | Preirradiation limits |      | Postirradiation limits |      |      |      | Unit  |
|---|-------------|---|----------------------|-----------------------|------|------------------------|------|------|------|-------|
|   | Method      | Conditions  |                      | R, F, G AND H         |      | R, F AND G             |      | H 4/ |      |       |
|   |             |   |                      | Min                   | Max  | Min                    | Max  | Min  | Max  |       |
| <u>Subgroup 1</u>   |             |   |                      |                       |      |                        |      |      |      |       |
| Not applicable  |             |   |                      |                       |      |                        |      |      |      |       |
| <u>Subgroup 2</u>   |             | T <sub>C</sub> = +25°C  |                      |                       |      |                        |      |      |      |       |
| Steady-state total dose irradiation (V <sub>GS</sub> bias) 5/ | 1019        | V <sub>GS</sub> = 12V<br>V <sub>DS</sub> = 0  |                      |                       |      |                        |      |      |      |       |
| Steady-state total dose irradiation (V <sub>DS</sub> bias) 5/ | 1019        | V <sub>GS</sub> = 0<br>V <sub>DS</sub> = 80 percent of rated<br>V <sub>DS</sub> (pre-irradiation)                     |                      |                       |      |                        |      |      |      |       |
| End-point electricals:  |             |   |                      |                       |      |                        |      |      |      |       |
| Breakdown voltage, drain to source                            | 3407        | Bias condition C<br>V <sub>GS</sub> = 0<br>I <sub>D</sub> = 1 mA  | V <sub>(BR)DSS</sub> | 30                    |      | 30                     |      | 30   |      | V dc  |
| Gate to source voltage (threshold)                            | 3403        | V <sub>DS</sub> ≥ V <sub>GS</sub>   | V <sub>GStH1</sub>   | 2.0                   | 4.0  | 2.0                    | 4.0  | 1.5  | 4.0  | V dc  |
| Gate current  | 3411        | Bias condition C<br>V <sub>GS</sub> = 20 V<br>V <sub>DS</sub> = 0   | I <sub>GSSF1</sub>   |                       | 100  |                        | 100  |      | 100  | nA dc |
| Gate current  | 3411        | Bias condition C<br>V <sub>GS</sub> = -20 V<br>V <sub>DS</sub> = 0  | I <sub>GSSR1</sub>   |                       | -100 |                        | -100 |      | -100 | nA dc |
| Drain current   | 3413        | Bias condition C<br>V <sub>GS</sub> = 0<br>V <sub>DS</sub> = 80 percent of rated<br>V <sub>DS</sub> (pre-irradiation) | I <sub>DSS1</sub>    |                       | 10   |                        | 10   |      | 25   | µA dc |

See footnotes at end of table.

\* TABLE II. Group D inspection - Continued.

| Inspection<br>1/ 2/ 3/                        | MIL-STD-750 |  | Symbol             | Preirradiation limits |       | Postirradiation limits |       |      |       | Unit |
|---|-------------|--|--------------------|-----------------------|-------|------------------------|-------|------|-------|------|
|   | Method      | Conditions   |                    | R, F, G AND H         |       | R, F AND G             |       | H 4/ |       |      |
|   |             |  |                    | Min                   | Max   | Min                    | Max   | Min  | Max   |      |
| <u>Subgroup 2</u><br>-Continued               |             |  |                    |                       |       |                        |       |      |       |      |
| Static drain to source on-state voltage<br>6/ | 3405        | Condition A<br>V <sub>GS</sub> = 12 V<br>pulsed (see 4.5.1)<br>I <sub>D</sub> = 45 A | V <sub>Dson1</sub> |                       | .180  |                        | .180  |      | .2025 | V dc |
| Static drain to source on-state voltage       | 3405        | Condition A<br>V <sub>GS</sub> = 12 V<br>pulsed (see 4.5.1)<br>I <sub>D</sub> = 45 A | V <sub>Dson1</sub> |                       | .1575 |                        | .1575 |      | .180  | V dc |
| Forward voltage source to drain diode         | 4011        | V <sub>GS</sub> = 0<br>I <sub>D</sub> = 45 A   | V <sub>SD</sub>    |                       | 1.3   |                        | 1.3   |      | 1.3   | V dc |

1/ For sampling plan, see MIL-PRF-19500.

2/ Group D qualification may be performed anytime prior to lot formation. Wafers qualified to these group D QCI requirements may be used for any other specification utilizing the same die design.

3/ At the manufacturer's option, group D samples need not be subjected to the screening tests, and may be assembled in its' qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

4/ The "H" designation represents devices which pass end-points at the G, R, and F designated Total-Ionizing-Dose (TID).

5/ Separate samples shall be pulled for each bias.

6/ Limit using TO-204AE package. The higher package resistance necessitates the higher  $V_{Dson1}$  limit when the manufacturer uses the alternate package as allowed in 4/ above.

TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only.

| Inspection                 | MIL-STD-750 |                               | Qualification and large lot quality conformance inspection |
|----------------------------|-------------|-------------------------------|--|
|                            | Method      | Conditions                    |  |
| <u>Subgroup 1</u>          |             |                               | 45 devices<br>c = 0  |
| Temperature cycling        | 1051        | Test condition G, 500 cycles. |  |
| Hermetic seal              | 1071        |                               |  |
| Fine leak                  |             |                               |  |
| Gross leak                 |             |                               |  |
| Electrical measurements    |             | See table I, subgroup 2.      |  |
| <u>Subgroup 2 1/</u>       |             |                               | 45 devices<br>c = 0  |
| Steady-state gate bias     | 1042        | Condition B, 1,000 hours.     |  |
| Electrical measurements    |             | See table I, subgroup 2.      |  |
| Steady-state reverse bias  | 1042        | Condition A, 1,000 hours.     |  |
| Electrical measurements    |             | See table I, subgroup 2.      |  |
| <u>Subgroup 4</u>          |             |                               | Sample size<br>N/A   |
| * Thermal impedance curves |             | See MIL-PRF-19500.            |  |
| <u>Subgroup 5</u>          |             |                               |  |
| Not applicable             |             |                               |  |

See footnotes at end of table.

TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only - Continued.

| Inspection   | MIL-STD-750 |  | Qualification and large lot quality conformance inspection |
|--|-------------|--|--|
|  | Method      | Conditions   |  |
| <u>Subgroup 10</u><br><br>Commutating diode for safe operating area test procedure for measuring dv/dt during reverse recovery of power MOSFET transistors or insulated gate bipolar transistors | 3476        | Test conditions shall be derived by the manufacturer   | 22 devices<br>c = 0  |
| <u>Subgroup 11</u><br><br>SEE <u>2/ 3/ 4/</u><br><br>Electrical measurements <u>5/</u><br><br>SEE irradiation  | 1080        | See figure 5.<br><br>$I_{GSSF1}$ , $I_{GSSR1}$ , and $I_{DSS1}$ in accordance with table I, subgroup 2<br><br>Fluence = $3E5 \pm 20$ percent ions/cm <sup>2</sup><br>Flux = 2E3 to 2E4 ions/cm <sup>2</sup> /sec<br>Temperature = $25 \pm 5$ °C<br>(ION - COPPER)<br>LET = 28 MeV-cm <sup>2</sup> /mg<br>Range = 40 microns<br>Energy = 261 MeV<br>Insitu bias conditions: $V_{DS} = 30$ V & $V_{GS} = -10$ V<br>$V_{DS} = 25$ V & $V_{GS} = -15$ V<br>$V_{DS} = 15$ V & $V_{GS} = -20$ V<br><br>(ION - BROMINE)<br>LET = 37 MeV-cm <sup>2</sup> /mg<br>Range = 37 microns<br>Energy = 285 MeV<br>Insitu bias conditions: $V_{DS} = 30$ V & $V_{GS} = -10$ V<br>$V_{DS} = 22.5$ V & $V_{GS} = -15$ V<br>$V_{DS} = 15$ V & $V_{GS} = -20$ V<br><br>(ION - IODINE)<br>LET = 60 MeV-cm <sup>2</sup> /mg<br>Range = 33 microns<br>Energy = 344 MeV<br>Insitu bias conditions: $V_{DS} = 25$ V & $V_{GS} = -5$ V<br>$V_{DS} = 20$ V & $V_{GS} = -10$ V<br>$V_{DS} = 15$ V & $V_{GS} = -15$ V<br>$V_{DS} = 7.5$ V & $V_{GS} = -20$ V | 3 devices  |
| Electrical measurements <u>5/</u>  |             | $I_{GSSF1}$ , $I_{GSSR1}$ , and $I_{DSS1}$ in accordance with table I, subgroup 2  |  |

1/ A separate sample for each test shall be pulled.

2/ Group E qualification of SEE testing may be performed prior to lot formation. Qualification may be extended to other specification sheets utilizing the same structurally identical die design.

3/ Device qualification to a higher level LET is sufficient to qualify all lower level LETs.

4/ The sampling plan applies to each bias condition.

5/ Examine  $I_{GSSF1}$ ,  $I_{GSSR1}$ , and  $I_{DSS1}$  before and following SEE irradiation to determine acceptability for each bias condition. Other test conditions in accordance with table I, subgroup 2 herein, may be performed at the manufacturer's option."

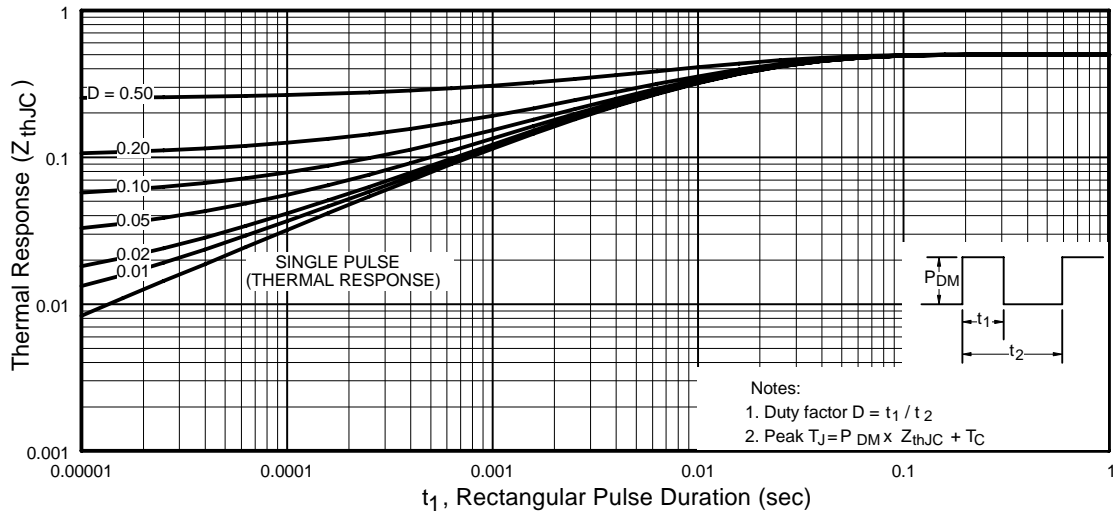


FIGURE 2. Thermal impedance curves.

### Maximum Current Rating

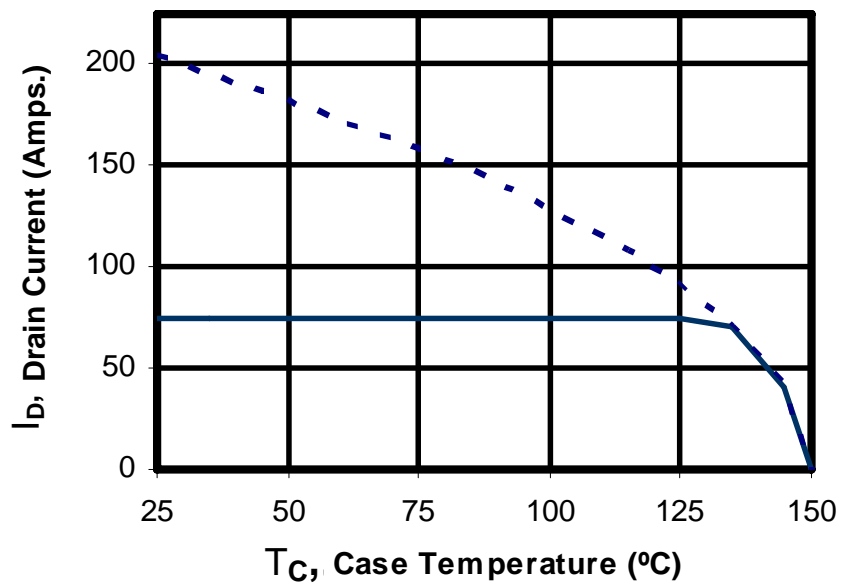
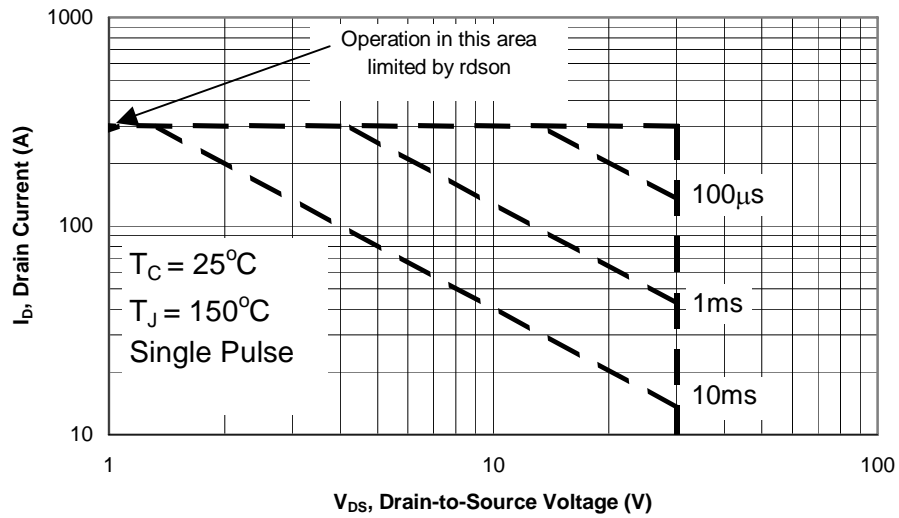
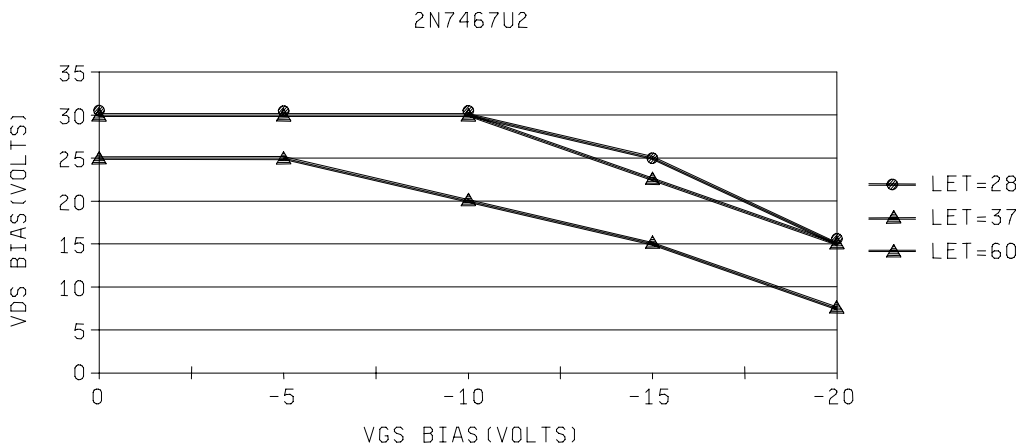


FIGURE 3. Maximum drain current vs case temperature graph.

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FIGURE 4. Safe operating area graph.FIGURE 5. SEE safe operation area graph.



## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

\* (This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in MIL-PRF-19500 are applicable to this specification.)

\* 6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. Product assurance level and type designator.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail [vqe.chief@dla.mil](mailto:vqe.chief@dla.mil).

6.4 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN). This information in no way implies that manufacturer's PIN's are suitable for the military PIN.

| Preferred types | Commercial types |
|-----------------|------------------|
| 2N7467U2        | IRHNA57Z60       |

\* 6.5 JANC die versions. The JANHC and JANKC die versions of these devices are covered under specification sheet MIL-PRF-19500/741.

6.6 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

Army - CR  
Navy - EC  
Air Force - 11  
NASA - NA  
DLA - CC

Preparing activity:

DLA - CC

(Project 5961-2008-024)

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